

REMARKS

Claims 1-36, including independent claims 1 and 19 remain in the application. Claim 1 stands objected to under 37 CFR §1.75(a), as failing to particularly point out and distinctly claim the subject matter which the applicant regards as his invention or discovery. Claims 1-13, 15-31, and 33-36 stand rejected under 35 USC §102(e) as being anticipated by U.S. Patent No. 6,842,638 to *Suri et al.* Claims 14 and 32 stand rejected under 35 USC §103(a) as being unpatentable over the combination of *Suri et al.* and U.S. Patent No. 5,891,030 to Johnson et al.

Independent claim 1 has been amended to recite the further limitation that said region specifying unit establishing an orthogonal cross sectional region to the longitudinal direction of the target vessel by marching along the target vessel without having first determined a center point of each vessel. Claim 1 has also been amended to overcome the rejection under 37 CFR §1.75(a) by correcting the antecedent basis for “said region specifying unit”. No new matter has been added to the application. Applicant respectfully submits that this element distinguishes independent claim 1 from *Suri et al.* and provides benefits to the medical image processing apparatus not contemplated or disclosed by *Sure et al.* Therefore, applicant respectfully submits, and will endeavor to set forth, that independent claim 1 is patentably distinct over *Suri et al.*

The Examiner asserts that *Suri et al.* discloses a medical imaging processing apparatus for generating a medical image by using three-dimensional volume data representing a portion of a living body, said apparatus comprising, a volume data obtaining unit, a region specifying unit, an extraction unit, “a center specifying unit (Fig. 16, No. 400) for specifying a center position of a cross-section of the tubular tissue in each of the plurality of regions specified by said region specifying unit (Fig. 16, No. 402)”; and a medical image

generating unit.

The Examiner directs us to Fig. 16, which discloses a flowchart beginning with box 386 (2-D binary slice with flood-filled vessel structures) from which box 400 (vessel centered taggers) is developed and subsequently to box 402 where vessel centers are identified. The following box 404 identifies vessel structures having more than one vessel center. The center specifying unit of *Suri et al.* differs from the center specifying unit of the present application by the recitation in Column 8, Lines 7-21 of *Suri et al.*:

An edge volume processor 48 receives the output of the pre-processor 46, and applies a mathematical transformation such as second order spatial differentiation to obtain an edge-enhanced volume that particularly emphasizes the edges of the vasculature.

A vessel-centered tagger 50 receives the output of the edge volume processor 48 and searches the edge volume for vessel centers, e.g. on a slice-by-slice basis. The located vessel center points in each plane are tagged. Vessel centers corresponding to overlapping images are advantageously identified and particularly noted. The vessel centers along with the overlapped tags are supplied along with the edge volume image and the pre-processed volume image to a vessel segmentation engine 52.

Therefore, center points of target vessels of *Suri et al.* are identified and tagged by a mathematical calculation based upon the edge volume of a vessel as determined by the edge volume processor 48. The center points of the target vessel are established prior to identifying cross sections of the target vessel. The edge volume processor 48 distinguishes the overlapped identification, as best represented in Fig. 6A of *Suri et al.* where a vessel splits into two branches thereby yielding two center points of a two-dimensional segmentation. This is clearly represented in Fig. 6A where two center points identified as 102₁ and 102₂ are shown.

An analysis of this type based upon only volume data derived from edge volume

slices fails to distinguish when two adjacent vessels having different compositions are adjacent. This is best represented in Fig. 34 of the present application with a first vessel V_t is adjacent a second vessel V_x . Using the methodology and apparatus set forth in *Suri et al.*, one would not be able to distinguish vessel V_t from vessel V_x and could erroneously extrapolate a single-branched vessel.

Furthermore, *Suri et al.* requires predetermining center points of the vessels as identified in Figure 16, where the vessel centers tagger is identified as block 400 and the vessel centers are identified as block 402 of the *Suri et al.* flow chart. From this determination the vessel structures are identified as having more than one vessel center in block 404 of the flow *Suri et al.* flow chart. As will be more evident when explained further, the identification of vessel centers in this manner does not provide the ability to distinguish between adjacent, but differing vessels. In fact, it would be difficult to distinguish between a target vessel and adjacent heart tissue.

The apparatus of the present invention makes use of a “*region specifying unit*” not disclosed in *Suri et al.*. The “*region specifying unit*” claimed in the present invention establishes an orthogonal cross sectional *region*. As set forth in paragraph 197 of the present application:

Then, the control unit 310 specifies a region (surface) (hereinafter referred to as “orthogonal cross sectional region SR) in whose center the start point SP is positioned and which is orthogonal to the longitudinal direction of the target vessel V_t passing through this center position, based on the specified coordinates (step S303). This orthogonal cross sectional region SR is a quadrilateral plane which has a certain width and a certain length. An operator designates the orientation of the orthogonal cross sectional region to be orthogonal to the vessel V_t .

Paragraphs 198 though 205 of the present application describe the “marching”

performed by the regions specifying unit by which the apparatus of the present invention establishes the orthogonal cross sectional region that does not require first determining a center point of each vessel. This is also best distinguished by following the flow chart shown in Figure 10 of the present application. Regions are first specified that are parallel with a temporary progressing (marching) direction. A longer direction of the cross sectional images of the vessel are determined and then the centers of the acquired images are calculated. Next, the progressing (marching) direction is focused based upon the center position of the vessel. The settled progressing (marching) position establishes the next temporary marching direction and the process is repeated.

The **region** of the present invention is limited by the cross section clarifying process set forth in Figure 21. The distinguishing feature is that a threshold is excluded at which the image is larger than the desired region (S363). As set forth in paragraph 00241 of the present application:

Next, the control unit 310 refers to the threshold attribute table, and excludes the thresholds at which the center unit image is not fit inside the orthogonal cross sectional region SR_ex2 (step S363). This exclusion is done because in a case where the cross section of the target vessel has a generally circular shape and is positioned in the center of the orthogonal cross sectional region SR, the image of the cross section whose outline is clarified (or clarified image) can not extend beyond the orthogonal cross sectional region.

This is contrasted with Figure 5 of *Suri et al.* where the edge of the vessel is used to calculate the vessel center tags 82 to provide input to the vessel segmentation processor 86 thereby generating 3-D segmented vessels. In this manner, Suri et al. fails to provide a means to distinguish between adjacent, but different vessels.

The applicant of the present invention determined that adjacent vessels as shown in

Figures 15A and 34 can be distinguished by using CT values along with the regions specifying unit set forth above. As set forth in paragraph 221 of the present application, “the CT values are x-ray absorption factors acquired by modality 100 (CT scanner), and materials have their own fixed CT values, such as, for example, “water: 0”, “air:-10000”, etc. Accordingly, in a case where the cross-section of the target vessel V_t is imaged, only the target vessel V_t can be imaged and extracted by data-converting the picture elements corresponding to the CT values corresponding to the materials (blood, vessel wall, contrast medium, etc.) constituting the vessel.

Applicant respectfully submits that the claimed medical image processing apparatus of the present invention provides a benefit and solves a problem of identifying multiple vessels that is not contemplated by *Suri et al.* **In fact, the apparatus disclosed in *Suri et al.* could yield misleading information to an operator of the imaging apparatus because it does not provide the ability to distinguish between adjacent vessel V_t and V_x .** Therefore, applicant respectfully submits that independent claim 1 as presently amended is patentable over the *Suri et al.* prior art reference. Although each of the dependent claims, 2 through 18, are patentably distinct, applicant submits that these claims are also now patentable over the *Suri et al.* reference because these claims also include all of the elements recited in independent claim 1.

Independent claim 19 now recites in part, “a step of specifying a center position of a cross-section of the tubular tissue in each of the plurality of regions specified by said region specifying unit said step of specifying a region including establishing a region threshold and excluding areas beyond said threshold from said planar region thereby distinguishing adjacent vessels from said target vessel;”

As set forth above, *Suri et al.* fails to disclose a method of image processing where

one can distinguish the difference between a target vessel V_t and an adjacent vessel V_x . Specifically, by setting a minimum CT threshold, based upon the target vessel CT, adjacent vessels V_t and V_x can be distinguished. *Suri et al.* fails to disclose this step. Furthermore, the method by which *Suri et al.* identifies center positions of a tubular vessel could provide misleading information to an operator of the imaging process apparatus.

Accordingly, applicant respectfully submits that independent claim 19 as presently amended is patentably distinct over the method disclosed in *Suri et al.* Although dependent claims 20-36 are patentably distinct, applicant respectfully submits these claims also include each of the elements recited in independent claim 19. Therefore, applicant submits these claims have also been placed in a position for allowance.

Applicant further submits that the Examiner's rejection under 35 USC §103(a) over *Suri et al.* in view of Johnson et al. is now moot because the combination of *Suri et al.* and Johnson et al. lack all of the elements recited in independent claims 1 and 19. Specifically, no combination of these two prior art references discloses establishing a region threshold and excluding areas beyond the threshold from a planar region thereby distinguishing adjacent vessels from the target vessel.

Applicant respectfully submits that the present application has now been placed in a position for allowance. This allowance is respectfully requested.

Respectfully Submitted,

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